HOW TO SELECT

SPECTACLES

IN CASES OF

LONG, SHORT, AND WEAK SIGHT.

Being one of a Series of Lectures on Diseases of the Eye, delivered at the Nottingham and Midland Eye Infirmary.

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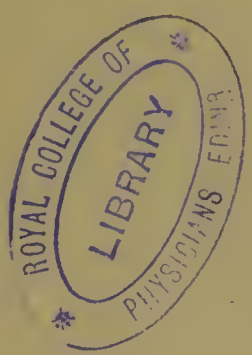
EYE INFIRMARY, ETC. ETC.



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CLINICAL LECTURES ON DISEASES OF THE EYE.

BY

CHARLES BELL TAYLOR, F.R.C.S. and M.D. EDIN.

LECTURE VII.

How to Select Spectacles.

GENTLEMEN,—I have here the left eye of a recently slaughtered ox. I know that it is the left eye by the position of the optic nerve, which always lies below the horizontal line, and to the inner or nasal side of the posterior pole. What is the "posterior pole"? Well, the "posterior pole" is a term borrowed from the language of geography, which serves to indicate the geometric centre of the back part of the globe of the eye. If I transfix this eyeball from before backwards with a hare-lip pin entered at the apex of the cornea (which is the anterior pole), it emerges, as you see, at the posterior pole, which I may mention *en passant* is in close proximity to the yellow spot—the most sensitive part of the retina; while the track of the pin—the optic axis—is nearly, not quite, but nearly, coincident with a line—the axis of vision—drawn through the object to which the eye is directed—to the *fovea centralis retinæ*, or yellow spot.* If I

* The axis of vision and the axis of the globe form with one another an angle of about six degrees, which is usually increased in hypermetropia, and diminished in myopia.

pass a thread round this eyeball transversely in the middle, an imaginary plane perpendicular to the axis, dividing the globe into two halves,—that is, the equator,—and the segments respectively are the anterior and posterior hemispheres. Planes at right angles to the equator, vertical and horizontal, are called meridians, and the interspaces, for the purposes of description, are termed quadrants. Thus we say of the youth who has just come into the accident ward, that he has been wounded by the impact of a piece of metal which has penetrated the lower and outer quadrant of the left eye,—that is, a space bounded above by the horizontal, and on the inner side by the vertical meridian.

It is on the assumption that the eyeball is a sphere that it has been called the globe, and in truth in the human adult it is nearly a sphere, measuring almost, not quite, an inch in diameter, and weighing on an average a little over a drachm and a half. Slight variations in shape (normal astigmatism) are, however, universal, and I have known the eyeball so drawn out as to measure fully an inch and a quarter from pole to pole, and in another case so flattened as to present an antero-posterior diameter of only three-quarters of an inch.

I have here another eyeball,—also, I perceive, a left one,—from which the sclerotic and choroid coats in the neighbourhood of the optic nerve have been removed, in order that you may see from behind the images of the objects to which the cornea is directed focussed upon the retina. The same phenomena may be observed without dissection, if you can obtain the eye of an albino or of a white rabbit, in which the pigment of the choroid is absent and the sclerotic almost translucent, or, better still, on the focussing screen of the photographic artist who is about to take a picture. In all these cases you will observe that the image is inverted, and considerable ingenuity has been expended at various times in endeavours to explain how it is that we who go about with inverted images

on our retinæ should see objects in the erect or real position. The most probable of these suggestions is that the cones of the retina, upper and lower, being directed respectively to a level above and below the eye, are able to accomplish a reversal of the image so far as the sensory impression on the brain is concerned (Fig. 1).

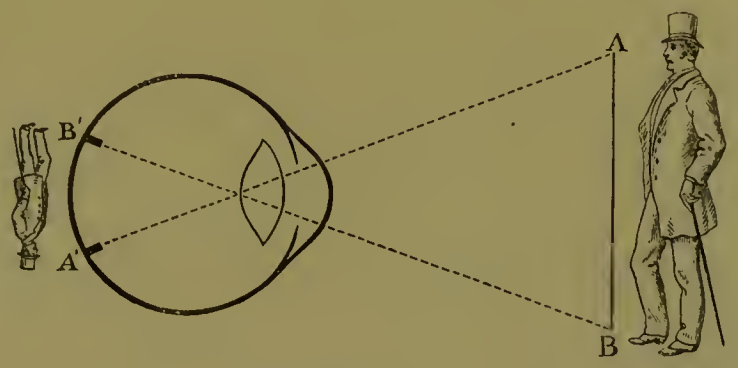

Fig. 1.

However that may be, it is clear that if the artist does not focus his subject accurately,—if his lens is too far away from the screen, or is too near, or if its outline is irregular,—his picture will be imperfect ; and it is exactly the same with the living eye. If it is too long (myopic), too short (hypermetropic), or if the cornea or lens presents an irregular surface so that the refraction differs in different meridians (astigmatic), not only do these conditions occasion well understood disturbances of vision, but they also give rise to certain objective physical phenomena which are elicited on examination, and which enable us to diagnose the defect from which the patient is suffering. For instance, if with the ordinary ophthalmoscope (a concave mirror of eight inches focus) you are able to see the optic disc at eight inches or thereabouts from the eye, you may rest assured that the eyeball is much too short (hypermetropic), or much too long (myopic). If it is too short, the image of the disc, which is a real or erect

image, will remain in view while you approach quite close to the patient and will move with you on slight inclination of the mirror ; but if it is too long, the image, which is an inverted one, will disappear on approach and will move in the opposite direction. On producing the inverted image in the ordinary way, by interposing a bi-convex lens—usually of two or two-and-a-half inches focus,—you will see a large disc and relatively small retinal field if the patient is hypermetropic, and a small disc and relatively large field if he is myopic ; while, on slowly withdrawing the lens, the apparent size of the disc continues the same in emmetropia or normal sight, gets larger in myopia, and smaller in hypermetropia ; in either of the latter cases in exact proportion to the degree of the defect.

Not only may you diagnose the exact condition with the ophthalmoscope, but it is easy also to prescribe the remedy without asking the patient a single question. In order to do this we must inspect the optic disc and blood-vessels simply magnified by the patient's refractive media, and as the lens and vitreous and aqueous humours collectively constitute a magnifying medium of short focus, it is necessary to get very close to the patient, using your left eye for his left eye, and your right for his right, bringing the patient's and surgeon's corneæ within an inch of each other. In this way, simply using the light reflected by the ophthalmoscope to illuminate the dark chamber of the eyeball, we obtain in the emmetropic or normal-sighted eye a good view of the optic disc and blood-vessels in their natural position, magnified about fifteen diameters by the patient's refractive media. If the picture should be blurred and indistinct, we know that the eye is either too short (hypermetropic), or too long (myopic), or irregular in shape (astigmatic). If too short, the image moves with the mirror on slight inclination of the observer's head ; if too long, it moves in the opposite direction ; if irregular in

shape you see the horizontal vessels well defined, while the vertical vessels are blurred and indistinct, or *vice versa*. In short, the surgeon sees into the eye under exactly the same conditions that the patient sees out of it, and the glass (placed behind the ophthalmoscopic mirror), concave, convex, or cylindrical, which best enables the surgeon to see into the eye, is also the one which will best enable the patient to see out of it.*

Owing to the close approximation of the persons concerned, the actual contact of faces necessitated by this, the direct method of ophthalmoscopic examination, the surgeon is obliged to hold his breath or breathe over the patient, while the emanations from the latter are sometimes very objectionable. The inconvenience thus occasioned has led to the adoption by many surgeons of the oro-nasal veil, an ingenious device invented by Mr. Ward Cousins, of Southsea, as also to the very general substitution of another and more exact method, for which we are indebted to Dr. Cuignet, ex-professor of ophthalmology at Lille. You will, perhaps, best appreciate Cuignet's process if you will give a few minutes' study to this simple contrivance, which, like the camera of the photographic artist, may be taken fairly to represent the living eye. It is simply a convex lens—the refractive media—with a cardboard screen—the retina—fixed in a clip on a movable slide, so that they may be brought together or separated at pleasure. Now you will find, if you throw the light of a lamp upon the lens, that you will get an erect (because twice inverted) image of the flame clearly defined if the screen is accurately in the focus of the lens, blurred and ill-defined if it is out of focus. If it is out of focus from too close approximation of the lens and screen (hypermetropia) the image will move away from

* It goes without saying that the surgeon must himself be normal sighted; if not, his ametropia must be corrected by spectacles while conducting the examination.

you on slight inclination of the mirror ; if it is out of focus because the lens and screen are too far apart (myopia) it will *seem* to move with you ; and if for the convex lens you substitute a cylinder, the motion will differ in opposite meridians (astigmatism). It is exactly the same with the living eye : if at a distance of three feet you throw the light of the ophthalmoscope upon the cornea and the image of the flame is perfect, you may conclude that the retina is in exact focus with the refractive media, and the patient emmetropic or normal sighted ; if the image is imperfect, the eye is too long (myopic), or too short (hypermetropic), or the cornea or lens is irregular in outline (astigmatic). If the eye is too long, the image *seems* to move with you on slight inclination of the mirror ; if normal, or too short, or if only very slightly myopic, it moves in the opposite direction ; and if the cornea or lens is irregular in outline, the motion of the image differs in opposite meridians. In order to select glasses by this method you must put spectacles upon your patient such as will approximately correct the defect, and then, throwing the light upon the cornea through the glass, judge by the perfected image, or its arrested, changed, or reversed motion, whether you have accurately neutralised the defect, or over-done or under-done correction. You may use a plane instead of a concave ophthalmoscopic mirror in conducting this examination, in which case you must stand at eight or twelve feet from the patient ; but you will find that with the plane mirror the image moves with you in hypermetropia, and against you in myopia. In alluding to this method I have throughout, in order to avoid confusion, spoken only of the image ; but, in truth, the shape and motion and blurred crescentic, or well-defined edge of the dense shadow which surrounds the illuminated portion or image of the flame is more easily appreciated by the observer, hence Dr. Cuignet's method has been termed the shadow test, or Skiaporescopy, from *σκια* (shadow), *πορεις* (march), and

σκοπειν (to regard or look at). Briefly we call it Skiascopy ; it has also been described as Retinoscopy, or Pupilloscopy ; and originally, from the erroneous attribution to the cornea of phenomena due to the fundas oculi, Keratoscopy. You can readily understand how very useful these objective methods of examination must be with children, with very stupid people, or with those who are attempting to deceive, and you may test them in actual practice upon any of the patients we have seen to-night.

The boy, for instance, who is eleven years of age, and who has what our French friends would term a "*nez retroussé*" and a generally hollowed-out set of features, is an interesting example of a common form of hypermetropia, or short eye—an affection which we frequently find associated with this cast of countenance. The lad's mother insists that he is near-sighted, because, as she says, he holds his book so close to his face, and some of you were inclined to adopt this opinion when, on glancing at the eye with the ophthalmoscope, you caught a glimpse of the fundus at twelve inches. We found, however, that we could see the optic disc as well or better on approaching quite close to the patient, and that the image—which was improved by a convex glass behind the mirror—moved with us—phenomena fatal to the mother's theory. We found, also, that with the inverted image we got a large disc and small retinal field, and that, on slowly withdrawing the object lens, the nerve got smaller. Skiascopy, too, with an imperfect image revealed a blurred shadow that moved against us, while convex spectacles on the patient's face cleared up the image and reversed the shadow. The conclusions thus arrived at were confirmed by the subjective symptoms, for we ascertained that after reading for a time the patient's vision became indistinct ; that he had been in the habit of wearing his grandmother's spectacles, and that distant vision was improved by convex glasses. Why, then, does this boy hold his book so

close to his face? Definition would certainly be improved by an interval, and one would think, *a priori*, that a hypermetrope like a presbyope, would prefer small objects at a moderate distance, and so he would; but in this case—as sometimes happens in hypermetropia—the patient has sacrificed definition for the sake of the large retinal images which he gets by the close approach of print to his eye. In these cases the eyeball is too short—a physical defect which, as you see, is made very apparent when the eyeballs are turned forcibly inwards—and the patient is continually making efforts to lengthen it. This, or its equivalent, he accomplishes by forcing the lens into a more convex form by the active exercise of the ciliary muscle. After a time this muscle gets tired, gives in, and small objects —such as print and stitches—fade from view. By placing a convex lens in front of the eye we practically lengthen it, thus obviating the necessity for this excessive accommodative effort, and the *strongest* glass with which the patient can see type an inch long at fifteen or twenty feet is the glass to prescribe. This will neutralise the whole of what is called the manifest hypermetropia, and after a time—which may be measured by months and even years—as the accustomed effort ceases and the spasm of the ciliary muscle gives way more and more, stronger and stronger glasses may be ordered, until the whole of the defect (the remaining latent hypermetropia) is neutralised. Now suppose—for it sometimes happens—that your hypermetropic patient's distant vision is embarrassed and not improved by convex lenses; nay, more, suppose—for it also sometimes happens—that his distant vision is improved by concave glasses, should we infer from this that a patient with short eyeballs was near-sighted? By no means! Our course under such circumstances would be plain: we should paralyse the ciliary muscle by the frequent instillation of a two per cent. solution of atropine and then test again, taking special care to order the patient to commence wearing the prescribed glasses before the effect of

the atropine had quite passed away. In any case the use of atropine will reveal the whole of the latent hypermetropia, and enable us to name the glass that will ultimately be required. Why not, then, use atropine for every case, and order such glasses as give complete correction at once? Simply because they would at first be too strong, and would only embarrass the patient, who is unable at once to relax a long-accustomed strain. In the case before us, number eighteen bi-convex is the strongest glass with which the patient can see distant objects: we shall therefore order spectacles of that strength for general use—(allowing a little stronger for reading, if necessary)—and change them for stronger ones as soon as the symptoms return. I have already, in my remarks on Strabismus, pointed out how it is that hypermetropia causes internal squint, and therefore need not say any more on this the most common form of ametropia.*

The girl, who is twelve years of age, and whom you noticed pinched her lids together when asked to read large type at twenty feet, clearly has eyes that are too long, for we

* When rays of light from distant objects which are parallel pass through a convex lens they are made to converge, and the distance of the point at which they are brought together—that is, to a focus—from the lens, is the measure of the lens. Concave glasses cause the rays of light to diverge, and the focus of the concave glass is ascertained by the number of the convex glass which is required to neutralise it; the two combined producing the effect of a piece of plain glass. A convex glass in front of a short eyeball converges the rays a little before entering the eye, so that they are brought to a focus sooner; a concave glass in front of a long eyeball causes the rays to diverge before striking the eye, so that they are brought to a focus later—in both cases, if the glasses are properly selected—on the retina. As this lecture was delivered to general practitioners, I used the terms inches and feet in preference to dioptrics and metres, which would not have been so well understood. The unit of the metrical system is called a dioptric, and is equivalent to the old lens of forty inches focus, so that in order to change the inch system into the metrical system it is only necessary to multiply by forty; thus, for instance, if we wish to ascertain the equivalent of a lens say of seven inches focus in dioptrics, we multiply one-seventh by forty—$\frac{1}{7} + 40 = \frac{40}{7} = 5{\cdot}5$ in dioptrics; to reduce the dioptric number to the inch system we must divide by forty, thus, four dioptrics, $4\ \text{D} = \frac{4}{40} = \frac{1}{10}$ in inches.

found on ophthalmoscopic examination that the optic disc, which was plainly visible with the mirror alone at eight inches or thereabouts, vanished on approach to the eye, while on getting quite close, the image, which re-appeared blurred, and which moved against us, was cleared up on placing a concave glass behind the mirror. Tested further, we found that with the inverted image produced in the usual way, we got a small disc and a large retinal field, and that on slowly withdrawing the object lens the small disc got larger. Skiascopy, too, revealed an imperfect reflection of the flame of the lamp, and a blurred shadow which seemed to move with us, while concave glasses on the patient's face brightened the reflection and reversed the shadow. The diagnosis thus arrived at was confirmed by the subjective symptoms, for the girl's father informs us that "she pores very close over her books;" that she reads by twilight and fire light; that she cannot discern the figures on the black board at school; and we have ascertained that in order to see type an inch long at twenty feet she requires concave glasses of fifteen inches focus. In these cases the eyeball is too long: originally of normal contour, it is gradually compressed into an ovoid form by the action of the internal recti muscles in the too frequent and too persistent effort at convergence necessary for binocular vision of near objects. A moment's examination of this model will enable you to appreciate the fact that such pressure will be most felt upon the posterior segment of the eyeball, where it is least supported, and here the globe bulges. This bulging of course lengthens the eye, and the longer it gets the nearer must small objects be approached in order to see, and the more must it be turned inwards, and the more it is turned inwards the longer does it become. Not only does the eye bulge, but the weakest part —which is situated just outside the optic disc—in the great majority of cases gives way, and here the stretched choroid, no longer supported, becomes absorbed, and the sclerotic, no

longer concealed, appears as a white patch—the well-known myopic crescent (Fig. 2).

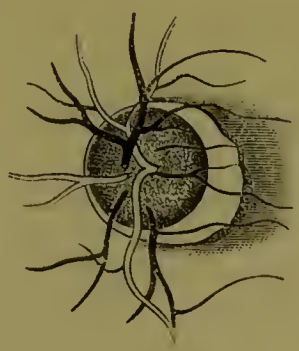

Fig. 2.

Young and plastic, and also lax and ill-nourished tissue, is, of course, more likely to yield than sterner stuff and more mature fibre, and patients of weak constitution are more prone to suffer than others; hence from five to fifteen is the most dangerous age, and delicate children and those who have recently recovered from an illness are most frequently affected.* Such patients, owing to their habit of nipping the lids together in order to exclude circles of diffusion, are called "myopes," from the Greek word μύν (to shut), and are in large proportion simply the victims of our modern system of high pressure education, for the eyes, which are used for hours daily on small and near objects, in many cases, as we have seen, lose their normal shape and become unable to distinguish large and distant ones. The faculty which is cultivated in the growing child naturally waxes, while that which is neglected wanes; the myope can see fine print more clearly and in a dimmer light—fire light, twilight, moonlight—than an individual with normal eyes, but his horizon

* It is the convergence which is necessary for the fusion of images upon the retinæ, which is the cause of all the mischief. When one eye only is used, as in the case of watchmakers, who pore over minute objects for hours daily, it is very seldom indeed that any ill result is noticed.

becomes very limited. The landscape, the seascape, the pleasant country scenery, the actors on the boards, the familiar faces—all fade, and but for the use of glasses which would blind an ordinary individual, would be shut out for ever. Some of these patients get worse steadily (progressive myopia); in others the disease advances by fits and starts until puberty, and sometimes afterwards (periodically progressive); and in others it is stationary, or advances very slowly, or even improves slightly with age.* Progressive cases, which in both forms are serious, must be met by appropriate treatment, such as paralysis of the accommodation by atropine, blue glasses, leeches to the temple (preferably the artificial leech), followed by a period of darkness from time to time, with tonics, aperients, and mild mercurials. All such patients, when studying or working—if they must work or study, should do so in a good light coming from the back, if possible over the left shoulder, and should never read when lying down, leaning forward, or travelling in a railway or other carriage.

With regard to glasses, we have seen that the cause of all the trouble is the excessive convergence necessitated by the too great devotion of such patients to near objects, and if they must continue their pursuits—even in a modified form—it is absolutely necessary that we should give them glasses that

* The myope, who pinches his lids together in order to diminish the sight hole, of course sees better through a small aperture than a large one, and this improvement with age is entirely due to the gradual contraction of the pupil, which goes hand in hand with advancing years. When a short-sighted person says, "I am not so short-sighted as I used to be," he usually means, however, that he is beginning to suffer from aged vision, and cannot see objects so near to his eyes as formerly. He does not mean that he can see print farther off; but that he cannot see it so near. Such patients often require convex glasses for reading, and concave for distance. Persons with high degrees of myopia are able to read without glasses up to great age—hence short sight is commonly supposed to be strong sight; it is, nevertheless, weak sight, for such patients cannot see at a distance, and they are apt to lose the sight altogether from gradual extension of the myopic crescent, consequent increase of the blind spot, and ultimate detachment of the retina.

will enable them to hold print at twelve or fourteen inches from the eye, not that they may see better—be it thoroughly understood—but that they may see farther off. To display the beauties of nature—to prevent moody introspection and isolation from their fellows—to enable such patients to recognise faces across the street—is, no doubt, of much importance, as contributing to their enjoyment of life, as well as in an educational sense ; but it is altogether a secondary consideration compared to the necessity of preventing undue convergence, by giving the patient glasses that will enable him to hold his book a good distance from his face. The great danger in either case is, that we shall order glasses which are too strong. Such patients can hardly avoid exerting their accommodation, and the effort enables them to see better with a glass which is too strong, than with one which is exactly suited to the requirements of the case ; and just as in hypermetropia we are apt to prescribe glasses which are too weak, so in myopia we run a risk of ordering them too strong ; and just as atropine in hypermetropia reveals the whole of the defect, so will it in myopia enable us to get rid of this most embarrassing complication. In the case before us I shall suggest rest for some weeks, paralyse the accommodation, and keep out excess of light with blue spectacles ; afterwards, as there is as yet no myopic crescent, I hope to arrest the progress of the disease by weak glasses which may be worn constantly both for near and distant objects, thus enlarging the patient's horizon, and enabling her to hold print fourteen inches from the face.* Should she, in spite of glasses, insist on approaching print too close—and myopes, especially those whose visual acuity is below par, will some-

* Each case must be treated on its own merits ; but when the patient can see at a distance with concave glasses of twelve inches focus and more, such glasses may usually be worn constantly for all purposes ; when the patient requires stronger glasses than these to see at a distance, he must have glasses three or four numbers weaker for reading.

times, like the hypermetropic boy, do so for the sake of large retinal images—we must withhold glasses, for it is better that they should dispense with spectacles for near work, than that they should wear them and still exert their accommodation, and still converge, and still approach small objects too close to the eye.

Of course, in all these cases, the common-sense and best plan of treatment would be to remove the cause, to interdict reading and fine work for all threatened individuals, and if we could do this—if we could fulfil this plainest of indications—all would doubtless be well ; but, unfortunately, we are not consulted until the mischief is done. Moreover, it is seldom that such suggestions can be carried out, for the masses are coerced by the State, and the classes are competitively examined for all sorts of services until, in some cases, their eyesight is so damaged by study that they cannot pass the visual tests required for the office for which they have striven. Shortsight—unknown among savage tribes and tillers of the soil—makes its appearance first among the children at village schools, in the proportion of about one per cent. ; in schools of higher grade, twenty per cent. ; higher still, forty per cent. ; and Erismann has calculated that if the disease continues to increase in the same ratio that it has done for the last fifty years, in a few generations the whole population will have become myopic.

The mere cram—for it is not education in any true sense—is of course soon forgotten,—fades like the shadow on a wall ; but the damaged eyesight and impaired physique remain and are transmitted,—sad evidence of the folly of a great people, "who, wishing to improve, choose the worst," and for the sake of mere useless book learning, are content to sacrifice the most precious of senses.

The man, who is twenty-six years of age, is evidently both myopic and astigmatic, for we found on examination with the

ophthalmoscope that the retinal vessels which were defined in the vertical meridian were obscure in the horizontal, and that the disc, which was perceptible at eight inches, faded on approach, reappeared as a vertical oval on close contact, and was rendered more distinct but not perfectly visible by a weak concave lens behind the mirror. On producing the inverted image in the usual way you saw a comparatively small disc, which was oval in the horizontal meridian so long as the object lens was close to the eye, but which became first round and then oval in the vertical meridian as the lens was slowly withdrawn. Skiascopy, too, revealed an imperfect reflection of the flame of the lamp and a blurred fantastic shadow, which seemed to move with us in the myopic, and did move against us in the emmetropic meridian, while a concave cylinder worn by the patient cleared up the image and reversed the shadow. On asking the patient if he could see the time by the Exchange clock, he made the following curious and characteristic reply—"No, not always; yes, sometimes!" One would think that the eye that could distinguish the position of the index at one hour could do so at another, but it is not so with astigmatics; they can see when the hands are in a certain direction, but not when they are placed at right angles to the point of best vision. Hence on testing this patient with Mr. Carter's clock, we found that he could see fairly well when the parallel lines pointed from six to twelve—

FIG. 3.

but that on turning them from three to nine—

FIG. 4.

vision became obscure, and was not brought up to the normal standard until we placed a concave lens of twenty inches focus before the eye. You will naturally conclude from this that the patient is short-sighted in the horizontal meridian, and normal-sighted in the vertical meridian; but it is not so. Paradoxical as it may seem, he is really short-sighted in the vertical meridian, and normal-sighted in the horizontal meridian. I know it is the vertical meridian which is at fault, because a line is, optically speaking, a succession of dots or points, from each of which light is reflected; each reflection is, of course, accompanied by diffusion circles, and if the line is vertical these circles overlap in the vertical plane, consequently are not seen, and thus accentuate without otherwise interfering with the retinal image in that plane. But the rays which diverge in the horizontal direction in vertical myopia are seen, and do spread out the retinal image in the horizontal meridian, and thus impair sight in that direction. Hence patients with hypermetropia in the horizontal meridian have hypermetropic vision for vertical lines, and patients with myopia in the vertical meridian, myopic vision—as in the case before us—for horizontal lines. By placing a concave glass before the eye we get rid of the horizontal circles of diffusion by neutralising the vertical myopia, but the glass must be

confined to the meridian at fault; otherwise, while correcting the vertical meridian, which is short-sighted, we shall render the horizontal meridian, which is normal, hypermetropic. What is to be done? It is obvious that if we are to correct the defect, we must have a glass which will refract the rays in one meridian without interfering with the other; and such a glass you will find in the test case under the title of "cylinder"—that is, a lens which is a section of a cylinder of crown glass, flint glass, or pebble cut parallel to its axis, so that rays of light passing through the cylinder parallel to its axis are unaffected, while rays which strike the cylinder perpendicular to its axis are refracted in proportion to the strength of the glass (Fig. 5). Now you noted in the case before us

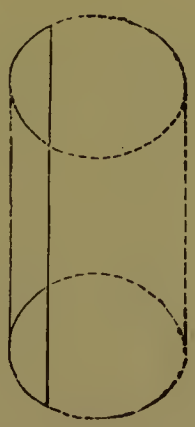

FIG. 5

that the patient (who is suffering from simple myopic astgimatism) easily defined vertical lines at fifteen feet without any glass, but that he required a spherical concave lens of twenty inches focus in order to see horizontal lines at the same distance. If we therefore order for him a *concave cylinder* of twenty inches focus, and place it so that its axis (which does not refract) corresponds with the horizontal meridian (which is not affected) we shall cure the dim vision

in the horizontal meridian by neutralising the myopia in the vertical meridian, and thus enable him, like persons with normal vision, to see parallel lines all round the clock with equal facility* (Fig. 6).

Fig. 6.

These cases of simple astigmatism, where the eye is normal in one meridian and myopic or hypermetropic in the meridian at right angles to it, are by no means uncommon; but it much more frequently happens that patients are myopic in one meridian and less myopic in the other, or that they are hypermetropic in one meridian and less hypermetropic in the other. With such patients who are suffering from what is called compound astigmatism, we must ascertain the number of the ordinary spherical glass required to correct each meridian separately, and then, either in dioptrics or fractions, deduct the lesser number from the greater, the resulting figure will give us the measure of the astigmatism and the number of the cylindrical lens necessary to correct it. It does not suffice, however, to have corrected the astigmatic meridian alone; there is still a remaining or resulting defect

* Persons affected with astigmatism frequently complain that they cannot see the horizontal lines of music, while the vertical are distinct, or *vice versa*. They also have difficulty in naming certain letters: P and F are mistaken the one for the other, C is called G or both are mistaken for O, while such letters as L and T are discerned at once.

to deal with, and this is corrected with an ordinary spherical glass after the cylinder is fixed, just as though there had been no astigmatism at all. For instance, a patient requires a concave or convex spherical glass of, say, twelve inches focus to see horizontal lines, and a concave or convex spherical glass of eight inches focus to see vertical lines : in order to ascertain the cylindrical lens necessary to correct the defect, we must deduct one-twelfth from one-eighth, and the resulting one-twenty-fourth is at once the measure of the astigmatism and the number of the cylinder required to correct it. Fix this glass with its axis coincident with the major visual defect, and you have at once reduced the case to its simplest elements, and need only to add the spherical glass—convex or concave, as the case may be—which is necessary to correct the remaining or resulting ametropia. It now and then happens, however, but not often, that the astigmatism is what is called mixed,—that is, the patient is hypermetropic in one meridian, and myopic in the other. When this is the case, we add the numbers of the lenses necessary to correct each meridian together, and having thus got the degree of the astigmatism and the number of the glass required to correct it, add the spherical glass necessary to neutralise the remaining ametropia, again just as though there had been no astigmatism at all. For instance, the patient requires for vertical lines a concave glass of twenty inches focus, and for horizontal lines a convex glass of twenty-four inches focus ; one-twentieth and one-twenty-fourth together give as near as may be one-eleventh ; consequently, a convex cylinder of eleven inches focus will correct the astigmatism, and we must then, as in the former cases, ascertain what spherical glass is necessary in addition to secure the nearest approach to normal vision. It is simpler still if you adopt the metrical system ; for instance, your patient has normal sight, say, in the horizontal meridian, and a myopia or hypermetropia of two dioptrics in

the vertical meridian, *i.e.* he has simple astigmatism of two dioptrics, and will require a concave or convex cylinder (as the case may be) of two dioptrics with its axis coincident with the visual defect, to remedy his ametropia. Or, he has myopia or hypermetropia of two dioptrics in one meridian, and three in the other, then we say the astigmatism is the difference between the two—namely one dioptric ; or he has one dioptric of hypermetropia in one meridian and one dioptric of myopia in the other, in which case the astigmatism equals the sum of both meridians—that is, two dioptrics,—and may be remedied by a cylinder of two dioptrics in conjunction with a spherical glass as just suggested, or by two cylinders, one for each meridian, that is, a lens with a convex cylindrical surface of one dioptric on one side and a concave cylindrical surface of one dioptric on the other ; the axes of the two, however, must, in this latter case, be precisely at right angles, a requirement which is apt to be defeated by the slightest rotation of the lens during the process of grinding.

Astigmatism was first discovered by the philosopher Young in 1793. Sir George Airey re-discovered it in 1827, and devised the remedy ; while Professor Whewell suggested that as the eye had no single focus the condition might be termed astigmatism, from *α* without, and *στίγμα*, a point.

Slight forms of the corneal affection are frequently neutralised by compensatory accommodative astigmatism of the lenticular surface, and do not become troublesome until the age of forty and upwards, when, owing to gradual hardening of the lens, the compensation can no longer be maintained.* You may always suspect this affection when, in the absence of actual disease, defective vision is not brought up to the normal

* A slight degree of astigmatism frequently complicates presbyopia, and in such cases glasses which previously were of little use will be found to answer perfectly on the addition of a weak cylinder.

standard, or near it, by ordinary glasses. Such patients when looking at the test types frequently hold the head on one side, and evidently see better through a slit, provided, of course, that the slit corresponds to the normal or least ametropic meridian. Instinctively, in order to obtain this advantage, they will make a small aperture with their fingers, or secure the same result by pulling the eyelids together and inclining the head on one side. The affection is usually symmetrical, affecting both eyes alike ; but as this rule is not invariable, it it is necessary to test each eye separately, and in every case to paralyse the accommodation by the frequent instillation of a solution of atropine.* Occasionally the astigmatism disappears under the influence of this drug, in which case you may be sure that it depended on distortion of the lens from abnormal accommodative effort ; indeed a certain amount of irregular lenticular astigmatism exists in all eyes. It was an abnormal variety of this lenticular affection from which our distinguished countryman Young suffered, and it is owing to slight degrees of the same variations of the different sectors of the lens that we all, or most of us, see luminous points, such as the fixed stars, not round but radiated.

The remaining patient, a female forty-three years of age, who, you will remark, has come here mainly on account of marginal blepharitis and a feeling as of sand in her eyes, is clearly suffering from presbyopia or old eye (πρεσβυς ωψ), for we found on ophthalmoscopic examination that the disc and blood-vessels were normal, while the image of the lamp, with the shadow test, moved against us. These negative signs,

* Glasses which answer every purpose so long as the effect of atropine endures, are nevertheless occasionally found unsuitable when the power of accommodation returns. In these cases it is necessary to increase the strength of the concave and reduce the strength of the convex glasses ; or we may work out the case again without the use of mydriatics ; or persuade the patient to persevere with his spectacles until he is able to dispense with the accommodative effort which interferes with their use.

combined with the age of the patient and the reflex irritation of the lids, are characteristic of presbyopia, a diagnosis which was fully confirmed by the subjective symptoms, for she tells us that her eyes ache on prolonged use: that she has lately been obliged to hold small objects, such as print and stitches, some distance from her eyes; that she has difficulty in threading a needle, and that by gaslight she has latterly been compelled to lay her work aside on account of pain, lachrymation, and intolerable irritation. All these symptoms are entirely due to a failure of the power of accommodation, which is as natural in advancing years as was the previous growth of the individual. What is accommodation? and why should it fail when so many persons have so many years of fine work for the eyes before them? Well, accommodation is the term which is used to express the power which we possess (up to a certain age) of rendering the lens more convex at will, as shown by these dotted lines (Fig. 7), by the active exercise

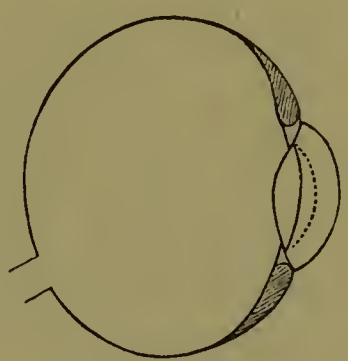

Fig. 7.

of the ciliary muscle, and as rays of light proceeding from near objects (unlike those from distant objects, which are parallel) are divergent, we are obliged to use that power whenever we look at small objects, such as print or stitches, in order that they may be focussed upon the retina.* That is accommoda-

* It is a mistake to suppose that staring at print or stitches for hours together is merely a passive process; it is, in truth, a serious muscular effort, and if unduly

tion, and it fails in the natural course of things, because, as time goes on, the lens, in common with other tissues of the body, loses its softness and compressibility, and becomes hard and inelastic, so that it is impossible for the ciliary muscle to affect its contour, and we are obliged to supplement deficient convexity of the crystalline lens by placing a convex glass in front of the eye. This gradual sclerosis—though long unperceived—commences at a very early age, and becomes manifest soonest in patients suffering from hypermetropia ; later on, in those with normal eyes; and lastly, and to a less degree, with those who are affected with short sight. Its advent is often marked by surface irritation, and the formation of styes and pustules, which are of reflex origin, as in the case before us, and the styes are cured and the irritation relieved by a convex glass of sufficient power to enable the patient to read small print at a distance of ten or twelve inches. Such patients, even without glasses, see much better through a pin hole or a small aperture, hence eserine in quarter-grain per cent. solution has been used to contract the pupil in the early stages in lieu of glasses, and in former times, when candles were in vogue, our fathers produced the same effect by holding the light between the face and the book, thus increasing the illumination and reducing the pupillary aperture at the same time.

It is better, however, when presbyopia has become manifest, for the patient to commence wearing spectacles ; for it has been found (contrary to popular belief) that sight fails more rapidly when glasses are withheld. In selecting them, certain

prolonged, or accomplished under difficulties, as in cases of hypermetropia or presbyopia, or with deficient light or defective media, is apt to be accompanied or followed by aching and fatigue, which is as natural as the aching and fatigue which are occasioned by any other excessive or unaccustomed exercise. Congenital and miner's nystagmus is caused by the muscular strain in the endeavour to see, just as writer's cramp, auctioneer's spasm, and that curious affection known as ballet dancer's leg, is produced by prolonged and unnatural effort.

arbitrary rules have been adopted which are so generally useful that you may *cæteris paribus* tell the age of the patient by the number of the glass he requires ; thus, at forty years of age he will need a convex lens of thirty-six inches focus ; at forty-five, a lens of thirty inches ; at fifty, a lens of twenty inches ; at fifty-five, one of fourteen ; at sixty, one of ten ; at sixty-five, one of nine ; at seventy, one of seven ; at seventy-five, one of six ; and at eighty, one of five inches focus. It will be seen that it is necessary to change the glasses every five years, but seldom oftener ; and it is well to note this, for a more rapid loss of accommodation necessitating a more frequent increase of strength is one of the earliest, as it is also one of the most important of the symptoms of glaucoma. You will note that the addition of a convex glass to the passive eye is exactly equivalent to an effort of accommodation ; and if we therefore order this patient a convex glass of thirty inches focus, we shall, so far as the deficient compressibility of the lens is concerned, have fulfilled all the requirements of the case. There is another function, however, with which accommodation is always intimately associated, namely, convergence, and if your patient's work should happen to be of the finer sort, or if he should require glasses of high power, the strain upon the internal recti in order to turn the eyes sufficiently inwards when reading or working, is ofttimes so great as to cause most unpleasant symptoms, such as weariness, discomfort, headache, myalgia, lachrymation, and surface irritation. You will find this state of things will vanish as if by magic by the use of prisms of two or three degrees, with their bases inwards, in addition to the necessary spherical lens, either in orthoscopic combination,* in simple

* In orthoscopic lenses, the two elements—a sphere and a prism—are so combined that they are coincident in their action, that is the prisms produce convergence of the visual lines exactly at the focus of the lenses, and their orthoscopic character may be demonstrated by throwing the light of a lamp with

combination, or better still by shifting the centre of the convex glass inwards, or by narrowing the frame of the spectacles, so that the lens acts like a prism itself, thus resting the convergence and the accommodation at the same time.

You can readily understand that if a presbyope's fatiguing efforts at convergence are relieved by a decentred glass, having the effect of a prism with its base inwards, that his troubles will be greatly increased by a decentred glass having the effect of a prism with its base outwards; of course no one would think of adopting such an expedient as this purposely in such cases; but the same effect is not unfrequently produced from carelessness in framing the spectacles, so that the eye does not look through the centre of its corresponding lens, but is displaced outwards, or whenever the frame of the glass is too wide, so that the patient looks through the outer side of the lens, in fact through prisms which compel increased convergence. Care is necessary in measuring the distance between the pupils with compasses before glasses are adopted in every case in order to avoid these accidents, and whenever there is any doubt, it is well to test the spectacles with a phakometer or lens measurer, an instrument devised by Dr. Snellen, of Utrecht, and which you will

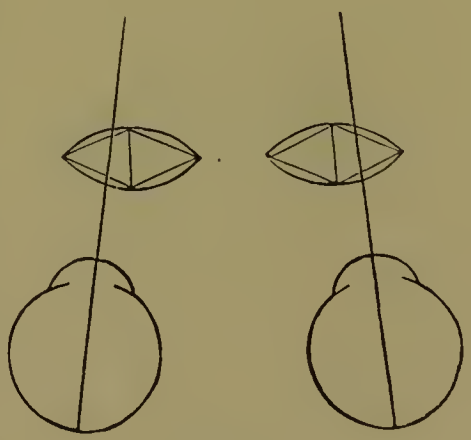

Fig. 8.

two such lenses (fixed in a spectacle frame at a certain distance apart) on to a screen, when only one image of the flame will be produced. Mr. Carter recommends the following combinations :—a thirty-two inch convex lens with a prism of $4\frac{1}{2}$ deg.; a twenty-two inch with a prism of 6 deg.; one of twenty inches with a prism of $7\frac{1}{2}$ deg.; and one of sixteen inches with a prism of 9 deg.; the centres of the glasses being in each case placed exactly sixty-two millimetres apart.

find fully described in Mr. Carter's admirable "Lectures on Defects of Vision."*

Spectacles are usually manufactured of crown glass or flint glass. Crown glass is composed of silicate of lime and soda, with a slight admixture of boracic acid; while flint glass, which is very hard but unnecessarily heavy, contains in addition to silicate of lime, the same salt of lead. The best material, however, is natural rock crystal or pebble, which is very hard, and therefore not so liable to be scratched—which is a ready conductor of heat, and therefore cooler than glass—and which is of high refractive power, and therefore, focal length for focal length, lighter than glass. On the other hand, pebble is expensive, and it is also bi-refringent, so that unless it is cut in planes parallel to the axes of double refraction, the pencil of light is split into two portions. It is true that in spectacles of low power this defect would hardly be noticed; but it is better in all cases before purchasing to test the lens yourself by placing it between two plates of tourmaline or selenite—(all opticians keep a small hand clip for this purpose)—when you will find on holding the glass to the window or sky, that if the spectacles are pebble the light will be polarised, and if they are correctly cut that the coloured zones will be circular. Tinted glasses without refractive power are very useful as shades and protectors, and of these blue spectacles, which exclude the orange or irritating rays of the spectrum without interfering materially with definition, are the best; French grey or London-smoke glasses have a similar effect, but shut out too much light; yellow glasses, which act like bright light, have proved beneficial in certain cases of amblyopia; and green spectacles, which absorb the heat rays, are necessary for furnace tenders and those who are exposed to the excessive glare of a tropical sun; while red

* London: Macmillan & Co. 1877.

glasses enable the colour-blind to get over their great difficulty of distinguishing between red and green. In order to shut out side lights these coloured glasses are curved in some instances sufficiently to give them slight magnifying power, a property specially objectionable in cases of myopia. The exclusion of light is attainable without this drawback, by sides and also by filling up the margins with crape or wire gauze. Shells, which shut out all light and at the same time permit the patient to open his eyes just as he might in a dark room, have recently been devised by Dr. Wicherkiewicz, and enable patients who require to be treated in obscurity at the same time to enjoy society and take necessary exercise.*

Gentlemen,—Voltaire used to say that the nose was made solely for the purpose of supporting spectacles, and certainly the kind of frame is determined in each case by the shape of that organ ; for instance, for flat faces the X shaped bridge is best adapted, as in Fig. 11, while the K shaped (Fig. 9), suits ordinary features, and the C bridge (Fig. 10) is suitable for

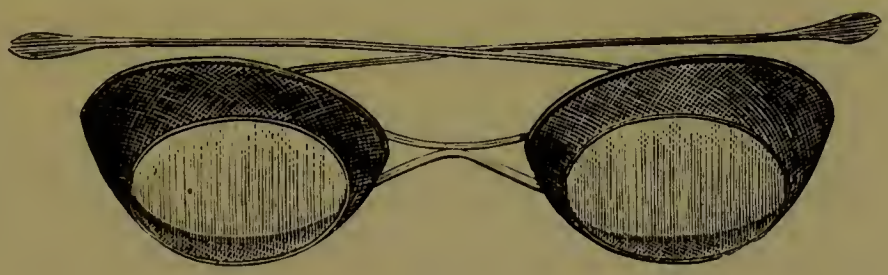

Fig. 9.

Fig. 10.

* May be obtained from Krohne and Sisemann, Duke-street, Manchester-square.

those with prominent nasal organs. The glass itself is variously shaped, being round, oval, or semi-lunar, the latter form being specially adapted for the presbyope who wishes to look over his glass ; while the pantoscopic, Franklin, or *verres à double foyer* (Fig. 11), are specially suited for those who are

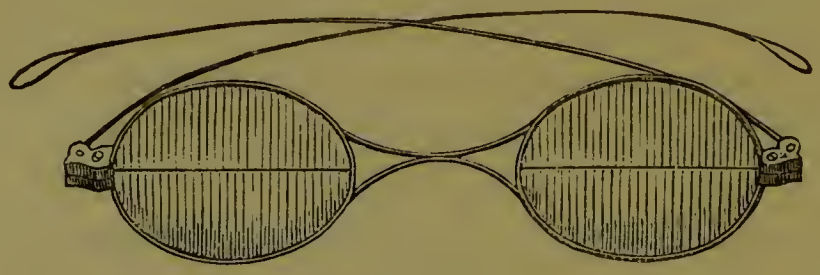

Fig. 11.

both myopic and presbyopic, who have undergone cataract extraction, or who, for other reasons, require glasses of different powers, for distant and near objects.

Glasses may be mounted on frames and nose clips of all sorts and patterns, and I have here a very ingenious contrivance by Messrs. Pickard and Curry, which may be used instead of spectacles in cases of astigmatism. I do not think I need say more on this occasion about spectacles. I must however, in conclusion, remind you that such aids to vision were practically unknown in this country until the reign of Richard II., and that until a very recent period thousands of those who became blind from cataract and other curable diseases remained in darkness for the rest of their days.

"Oh, dying years ! Oh, flying years !
Oh, days of dimness, nights of sorrow ;
Oh, failing sight ! Oh, lessening light !
Oh, morn forlorn and sad to-morrow."

Now, thanks to such Institutions as the one in which I have the honour to address you, few escape operation, and so slight is the disability afterwards, that I am enabled to show

you this small coin within the narrow circle of which has been inscribed the Lord's Prayer by a patient who was formerly blind from cataract; also this beautiful landscape which was painted for me by a patient two years after undergoing extraction for cataract in both eyes. There is also in the waiting room at the present moment an elderly lady who still gets her living by mending lace, on whom I operated for double cataract twelve years ago; and some of you had an opportunity of seeing at our last meeting a gentleman who for the last eight years has filled the office of book-keeper in a large factory after undergoing extraction in both eyes ten years ago. Such triumphs of our art would not have been possible without the added aid of spectacles; and much as we may and do regret the necessity (which comes to us all) for their use, you have only to realise how helpless we should be without them in order to appreciate the immense boon conferred upon us by those philosophers whose unselfish devotion to science has perfected the art of selecting glasses, and enabled us not only to preserve and strengthen and improve the sight in youth—not only to heighten the colour, brighten the light, and bring back the fading outlines of minute objects in advancing years—but also to secure after surgical operations results which are little short of miraculous, and which without them would have been impossible, unsatisfactory, or only half complete.

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